(51) International Patent Classification⁷: H04B 7/005

(21) International Application Number: PCT/EP00/05944

(22) International Filing Date: 23 June 2000 (23.06.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
9914530.2      23 June 1999 (23.06.1999)   GB

(71) Applicant (for all designated States except US): MO-TOROLA LTD. [GB/GB]; Jays Close, Viables Industrial Estate, Basingstoke, Hampshire RG22 4PD (GB).

(72) Inventors; and
(75) Inventors/Applicants (for US only): ANDERSON, Nicholas [GB/GB]; 26 Church Hill, Wroughton, Swindon, Wiltshire SN4 9JS (GB). O'NEILL, Rorie [GB/GB]; 25 Applewood Court, Swindon, Wiltshire SN5 7AH (GB).

(74) Agents: TRELEVEN, Colin et al.; Motorola European Intellectual Property Operations, Midpoint, Alencon Link, Basingstoke, Hampshire RG21 7PL (GB).

(81) Designated States (national): AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— With international search report.
— Before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments.

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: APPARATUS AND METHOD FOR POWER CONTROL IN A RADIO COMMUNICATION SYSTEM

(57) Abstract: An apparatus and method for power control in a CDMA system for radio communication between a first station and a second station. At the first station an indication of the received power of signals from the second station is communicated to the second station, and at the second station the indication of received power is received and its transmission power is accordingly modified. An inner control loop produces a power control metric estimate, and an outer control loop produces an outer loop threshold signal (OLT) dependent on received quality of service (QoS). The outer control loop means produces a channel error rate signal (ChER) whereby to track channel variations. The power control is capable of compensating for variations in the channel type and speed. A dual outer-loop scheme allows desired QoS to be maintained for low-FER/high-data-rate services.

- 1 -

# APPARATUS AND METHOD FOR POWER CONTROL IN A RADIO
COMMUNICATION SYSTEM

## Field of Invention

This invention relates to power control in radio
communications systems such as CDMA cellular telephone
systems.

## Background of Invention

'Outer loop' power control is required in a CDMA system
to set an appropriate target for the 'inner loop' power
control loop which is just high enough to achieve the
desired quality of service (QoS). This target point
value will vary as a function of channel propagation
(e.g., dispersiveness or user speed). Without effective
power control, users perceived QoS will be severely
degraded or network capacity will degrade (as a result
of excess power transmission when exceeding desired
QoS).

In particular, dynamic outer-loop power control is
required in a CDMA system in order to adjust the Eb/No
(the ratio of energy per bit to noise power spectral
density) target point for an inner power control loop
in order to track changes in channel propagation in an
attempt to maintain constant QoS.

- 2 -

Future generations of cellular telephone services such
as the proposed Universal Mobile Telephone System
(UMTS) will offer a plethora of different services,
each with quite different QoS requirements in terms of
5   delay, bit error rate (BER) and frame erasure rate
(FER). This represents a challenge to mobile radio
equipment manufacturers who must therefore design their
products to be fully adaptable to these various
requirements.
10

Traditional methods for performing outer-loop power
control, such as those based on the 'sawtooth'
algorithm employed in existing CDMA networks (e.g., the
IS-95 cellular standard), are not appropriate for all
15  service types. This is especially true of low FER or
high delay services (e.g., video) - which are to be
deployed in next generation networks across the world.


20  **Summary of Invention**

In accordance with a first aspect of the present
invention there is provided an apparatus as claimed in
claim 1.
25

In accordance with a second aspect of the present
invention there is provided a method as claimed in
claim 7.


30

- 3 -

## Brief Description of Drawings

One embodiment of the invention will now be described,
by way of example only, with reference to the
5      accompanying drawings, in which:

        FIG. 1 shows in block diagrammatic form a system
        incorporating inner- and dynamic outer-loop power
        control as known in the prior art;
        FIG. 2 shows in block diagrammatic form a scheme
10       for re-encoded channel error rate measurement as
        employed in the preferred embodiment of the
        present invention;
        FIG. 3 shows in block diagrammatic form a system
        in accordance with a preferred embodiment of the
15       present invention incorporating a dual outer loop
        power control scheme (DOLAP);
        FIG. 4 shows a graph used in deriving an
        appropriate value for a counter parameter of the
        system of FIG. 3; and
20       FIG. 5 shows a block schematic diagram of a target
        channel error rate ($ChER_{Target}$) update scheme
        employed in the system of FIG. 3.

25   ## Description of Preferred Embodiment

Two-loop (inner-loop and outer-loop) power control is
known in CDMA cellular telephone systems. Dynamic
outer-loop power control is required in a CDMA system
30   in order to adjust the Eb/No target point for the inner
power control loop in order to track changes in channel
propagation (e.g., dispersiveness/user speed). Without

- 4 -

effective dynamic outer-loop power control, users
perceived QoS will be severely degraded or network
capacity will degrade (as a result of excess power
transmission leading to excessive QoS).

5

A diagram depicting inner- and dynamic outer-loop power
control is shown in FIG. 1. In this arrangement, the
transmit power 2 of a transmitter 4 is controlled via
an inner loop 6 contained within a receiver unit R. The

10    inner loop 6 includes inputs from the transmitted
power, a shadow (slow) fading profile 8, a fast-fading
profile 12, and noise interference 14. The fast-fading
profile 12 is itself dependent on the channel variation
(e.g., speed/dispersion) 10. For the inner loop 6,

15    receiver circuitry 16 produces from the signal received
at the receiver R a power control metric estimate
($PCM_{Est}$) – a function of received Eb/No – which is used
to modulate the transmit power 2 of the transmitter 4.
Additionally, an outer loop 18 is also used to control

20    the transmit power 2 of the transmitter 4. In the outer
loop 18 a quality of service estimate ($QoS_{Est}$) is
derived from the signal received at the receiver R and
is used to produce an outer loop threshold (OLT)
signal. The PCM estimate signal $PCM_{Est}$ from the inner

25    loop 6 and the OLT signal from the outer loop 18 are
compared and the result is used to control the transmit
power 2 of the transmitter 4.

Future generations of cellular telephone services such

30    as the proposed Universal Mobile Telephone System
(UMTS) will offer a plethora of different services,
each with quite different QoS requirements in terms of

- 5 -

delay, bit error rate (BER) and frame erasure rate
(FER). This represents a challenge to mobile radio
equipment manufacturers who must therefore design their
products to be fully adaptable to these various
5    requirements.


Traditional methods for performing outer-loop power
control, e.g., the outer power control loop scheme
(based on the 'sawtooth' algorithm) commonly deployed
10   in IS-95 CDMA networks, are not appropriate for all
service types. This is especially true of low FER or
high delay services (e.g., video) which are to be
deployed in next generation networks across the world.


15   The 'sawtooth' algorithm can be described as follows:-
QoS information in the form of frame cyclic redundancy
check (CRC) pass/fail is available from the receiver.
The frame quality indicator flag $q_k$ is set to +1 in the
event that the $k^{th}$ received frame was bad, and is set to
20   -1 in the event that the $k^{th}$ received frame was good. A
function $f(q_k)$ returns the outer loop step increment
based on the QoS input information $q_k$ where:-

$$f(q_k) = -\Delta \text{ for } q_k = -1 \quad \text{and} \quad f(q_k) = +K\Delta \text{ for } q_k = +1 \quad\quad (1)$$

That is, for every good frame received the OLT is
25   decreased by an amount $\Delta$, whereas for every bad frame
received the OLT is increased by an amount $K\Delta$. Using
the given notation the algorithm can be expressed in a
more mathematical form as:-

$$OLT(k+1) = OLT(k) + \frac{1}{2}\{(q_k + 1)K\Delta + (q_k - 1)\Delta\} \quad\quad (2)$$

- 6 -

A value of $K$ can be derived as a function of the
desired FER:-

$$K = \frac{1 - 2FER_{Target} + 1}{1 + 2Fer_{Target} - 1} = \frac{1}{FER_{Target}} - 1 \qquad (3)$$

Therefore, suppose for example an FER of 1% is desired,
then for every good frame received the algorithm
decreases the OLT by an amount $\Delta$, whilst for every bad
frame received the OLT is increased by $99\Delta$. This
results in the desired FER being attained.

An unwanted transmission power overhead, that is a
function of $K\Delta$, is required by the sawtooth algorithm
in order for it to attain the desired $FER_{Target}$. Thus, it
will be understood that the excess power transmitted
due to the dynamic outer-loop increases with $K=1/FER_{Target}$
and this is where one of the problems with low FER UMTS
services becomes apparent. Long constraint delay (LCD)
data services have been designed within the UMTS
framework to provide QoS's which are equivalent to
service frame erasure rates (SFER's) of around $10^{-3}$.
Thus, as there is a lower limit restriction on $\Delta$ for
channel tracking purposes, the step-up size $K\Delta$ becomes
very large and much excess power must be transmitted in
order to meet QoS. This would significantly reduce
network capacity, especially when considering the fact
that each high data rate LCD user consumes much more of
the power resource within a cell than each low data
rate (e.g., speech) user.

The problem here can be summarised in a more generic
form. The outer loop exists to track the channel

variations in speed and dispersion which may be
occurring over a time (e.g., 0.5 - 5 seconds). As an
example, a vehicular user may transition from 120kmph
to close to 0kmph in less than 5 seconds, where the
5  change in Eb/No at QoS will perhaps be of the order of
2dB's. The 'sawtooth' outer-loop algorithm is driven
solely by CRC fail information which, by definition,
only occurs very infrequently (e.g., SFER = $10^{-3}$).
Considering a typical UMTS LCD circuit-switched data
10 service with service frame duration of 80ms, this gives
rise to one service frame erasure approximately every
1.5 minutes for SFER$\approx 10^{-3}$! Therefore, for any
reasonable step-up ($K\Delta$) size, the outer loop will be
unable to track the channel variations adequately since
15 the corresponding step-down size ($\Delta$) will have to be
set to a very small value. In practical terms the
'sawtooth' algorithm is therefore only applicable to
low delay services with service frame erasure rates of
$10^{-2}$ or higher, or for non-real-time (NRT) services
20 employing automatic repeat request (ARQ). For real-time
(RT) services with QoS requirements for low error
probability another approach is required.

Thus it will be understood that a different approach is
25 required for LCD services that have a potentially long
service frame duration and/or very low SFER QoS
targets. In these services the influx of quality
information into the outer-loop mechanism is inherently
of too low a frequency to adequately track any channel
30 variations without resorting to transmitting large
amounts of excess power. For any practical value of $\Delta$
the excess power transmission required by the

- 8 -

'sawtooth' algorithm will be very high due to the large
value that must be assumed by $K$. Therefore, a more
frequent measure of link quality is required to track
the channel.

5

This invention is based on the realisation that the
channel bit error rate (e.g., after 'RAKE' maximum
ratio combining (MRC), but before channel-decoding)
corresponding to a particular post channel-decoding QoS

10    is relatively independent of the channel type and speed
(it will be understood that RAKE MRC is a technique
well known in CDMA systems). That is to say, for any
particular QoS, there exists a corresponding channel
error rate (ChER) that is by-and-large insensitive to

15    variations in the channel type and speed. Thus, if the
ChER at the desired QoS could be found, it would
provide a continuous measure to track channel
variations in the absence of any other information.
However, it may not be desirable to have to set a

20    specific desired ChER for each service and data rate
and some automated ChER-target-setting process may be
required.

Referring now to FIG. 2, an accurate estimate of the

25    ChER can be obtained from the receiver by comparing a
re-encoded version of the decoded information bits with
a hard decision on the soft channel bits emanating from
the receiver/demodulator. In the scheme of FIG. 2, a
receiver/demodulator 20 supplies output to a channel

30    decoder 22 which produces at its output presumed
information bits. The channel decoder output is applied
to a channel encoder 24 which produces at its output a

- 9 -

re-encoded version of the presumed information bits.
The output of the channel encoder 24 is compared to the
output from the receiver/demodulator 20 and applied to
an integrator 26. The output from the integrator 26 is

5    sampled and reset via a switch 28 at the end of each
desired measurement period to produce at its output a
re-encoded channel error metric (ReEnc_ChER)
commensurate with the received signal portion contained
within the measurement period.

10

It will be appreciated that for certain coding schemes
(e.g., recursive) it may be desirable for the re-
encoded input to the comparator to be derived other
than directly from the decoded bits. A suitable

15   alternative re-encoded metric could be obtained, for
example, by concatenating the codewords corresponding
to the most likely path through a decoder trellis. At
the QoS point, the ReEnc_ChER will be closely
representative of the real channel error rate ChER

20   (since, by definition, the decoded output contains very
few errors). In addition, ChER's of between 10% and 20%
are typical for turbo-coded LCD services at BER's of
$10^{-6}$ and so the effects of the infrequent errors in the
decoded bits on the re-encoded metric are very small.

25

Referring now also to FIG. 3, based upon the above
principle, an outer loop algorithm has been developed
that has two constituent loops and for convenience will
subsequently be termed the 'dual-loop algorithm' or the

30   'Dual Outer-Loop Algorithm for Power-control' (DOLAP).
As shown in FIG. 3, a received signal is applied to the
information bit recovery arrangement of FIG. 2 to

produce a re-encoded channel error rate metric
(ReEnc_ChER) and a cyclic redundancy check (CRC)
pass/fail signal ($CRC_{p/f}$) which is applied to an 'outer-
loop 1' (36). The ReEnc_ChER signal is applied to an
5     'outer-loop 2' (40) where it is filtered and compared
to a target channel error rate signal ($ChER_{Target}$) from
the 'outer-loop 1' (36) to drive a 'small gain step'
incrementer/decrementer 42. The 'outer-loop 1' (36)
also produces an output which drives a 'big gain step'
10    incrementer/decrementer 38. The outputs from the 'small
gain step' incrementer/decrementer 42 and the 'big gain
step' incrementer/decrementer 38 are combined to
produce a OLT increment/decrement signal ($OLT_{+/-}$) which
is used to derive the inner power control loop
15    threshold signal OLT.

Thus, the 'outer-loop 1' (36) monitors QoS information
in the form of CRC pass/fail events. In response to the
$CRC_{p/f}$ input, 'outer-loop 1' (36) then sets a target
20    channel error rate ($ChER_{Target}$) for the 'outer-loop 2'
(40), and also outputs relatively large OLT
increment/decrement adjustments ($\Delta_{big}$). In the absence
of further 'outer-loop 1' OLT adjustment events, outer-
loop 2 then attempts to maintain the specified $ChER_{Target}$
25    by comparing a filtered version of ReEnc_ChER to
$ChER_{Target}$ and adjusting the OLT for the inner PC loop in
smaller steps ($\Delta_{small}$) up or down. $\Delta_{big}$ and $\Delta_{small}$ may
represent multiplicative adjustments to the OLT in the
linear domain, or additions in the logarithmic domain
30    (in a similar manner as described for the 'sawtooth'
algorithm).

- 11 -

It may be beneficial to take an average of the re-
encoded channel error rate metric (ReEnc_ChER) over a
longer period in order to reduce its variance before it
5    is used by outer-loop 2. This filtering time duration
is irrespective of the service frame duration and data
rate.

Considering the outer-loop 1 in more detailed
10   description), the outer-loop 1 performs two functions:
        (i)     Monitoring Service Frame Quality-of-
                Service Indicator (SFQI) information and
                adjusting the OLT by steps $+/- \Delta_{big}$
                accordingly; and
15      (ii)    Determining $ChER_{Target}$ for outer-loop 2.

Considering firstly the outer-loop 1 function of
monitoring SFQI information and adjusting the OLT, the
algorithm for this process is as follows. $SFQI_n$
20   indicates whether the $n^{th}$ service frame was found in
error. A value of +1 indicates an error whereas a
value of -1 indicates a good service frame. On
encountering a SFQI indicating a CRC fail, the process
checks to see whether a service frame in the last T
25   service frames has also been found in error. If so,
the OLT is adjusted by an amount $+\Delta_{big}$. Upon a CRC fail,
a counter is reset. In the absence of further errors
this counter increments every subsequent service frame
until it exceeds the value T. When this happens, T
30   service frames have been received error-free, and the
OLT is adjusted by an amount $-\Delta_{big}$. The counter is again
reset upon this event.

- 12 -

The algorithm can be expressed algebraically as:-

$$[OLT(n)] = [OLT(n-1)] * \frac{\Delta_{big}}{2}\left( SFQI_n + \frac{T-counter}{\sqrt{(T-counter)^2}} \right) \quad (4)$$

The step size value for $\Delta_{big}$ should be large enough to

5    give an appropriate increment upon an undesired service
     frame erasure event, but must also be small enough so
     as to prevent much excess transmission of power above
     the QoS operating point. A typical value for $\Delta_{big}$ may be
     0.25 dB. Although recommendations for step sizes are

10   given in this example, optimisation of both $\Delta_{big}$ and $\Delta_{small}$
     could be performed.


     The value of T that results in the desired SFER has
     been found via modelling this outer-loop1 process as a

15   discrete 3-state Markov process. This modelling
     produces the graph of FIG. 4, which shows (T*SFER) vs.
     ($P_{err(tot)}$/SFER). From this graph it can be seen that in
     order to achieve the desired $SFER_{Target}$ the counter-
     related parameter T (in equation (4)) must be selected

20   to be:-

$$T = \frac{1}{SFER_{Target}} \times 0.66 \quad (5)$$

     Considering now the second function of outer-loop 1 of
     determining $ChER_{Target}$ for outer-loop 2, it is to be noted
     that the above-discussed algorithm for the first outer-

25   loop 1 function (monitoring SFQI information and
     adjusting the OLT) has a 'do nothing' state when
     neither a big step up nor a big step down event has
     occurred. In these periods, outer-loop 2 will attempt
     to maintain a constant channel error rate by adjusting

- 13 -

the OLT in small steps up or down in response to a
comparison of channel error rate estimate with the
channel error rate target. ChER$_{Target}$ is set subsequent to
a counter reset in the first function (i.e., when a big
5    step up or down has been made). Referring now also to
FIG. 5, the following ChER$_{Target}$ update process occurs.
When a counter reset in the first function occurs
(i.e., when a big step up or down has been made), this
condition is detected, and a wait period 50 (equal to
10   the delay of the re-encoded channel error rate filter
52) is entered, during which ReEnc_ChER is sampled and
averaged (which is occurring anyway for outer-loop 2).
After this delay period, the output of the ReEnc_ChER
averaging filter 52 is input into a ChER$_{Target}$ filter 54
15   that is clocked following every counter reset in the
first function. The output of this filter is the actual
ChER$_{Target}$ to be used by outer-loop 2.

Thus, the combined operation of outer-loop 1 and outer-
20   loop 2 can be summarised as follows. When the first
function of outer-loop 1 decides that a relatively
large step change in the OLT is required, it is
implemented and the new channel error rate is measured.
Once filtered using previous such measurements, this is
25   then assumed to be a new acceptable channel error rate
target for outer-loop 2 to track. In this way, the
outer power control loop is able to adaptively
determine the average channel error rate at the desired
QoS point for that service (these can be very different
30   for different services). Any variations in the channel
can then be tracked quickly by outer-loop 2 without the

- 14 -

need for further CRC event information (which by
definition arrives at a very slow rate).

5    It will be understood that the various filter
parameters may need to vary for different service frame
durations and different values of $SFER_{Target}$ since these
affect the average rate and variance of input
information into the $ChER_{Target}$ filter.

10   An initial channel error rate target must be set at the
start of a call. The target will be updated following a
counter reset in the first function of outer-loop 1. It is
desirable to set this initial target to a high error
rate (higher than any service ChER at desired QoS) such
15   that in the event that the initial OLT setting is too
high outer-loop 2 will drive down the power until the
first error is encountered. Following this the process
will automatically set its own suitable $ChER_{Target}$. Care
must be taken therefore to ensure that the initial
20   value of $ChER_{Target}$ does not enter the $ChER_{Target}$ filter. In
the case that the initial OLT target is too low, errors
will be encountered and the process will adapt itself
accordingly.

25   The function performed by outer-loop 2 is very simple.
It accepts two inputs: (i) the filtered version of
ReEnc_ChER, and (ii) $ChER_{Target}$. Outer-loop 2 simply
compares these two values and adjusts the OLT
accordingly.
30

It may be desirable that the value of $\Delta_{small}$ *per second* is
similar to the step-down size $\Delta$ *per second* used in the

- 15 -

'sawtooth' algorithm for speech services in order to
ensure that both algorithms have similar channel-
tracking capability.

5      Simulation tests have shown that power control
utilising the above-described dual loop (DOLAP) scheme
allows desired QoS to be maintained for low-FER/high-
data-rate services. The simulation tests also showed
that power control utilising the above-described dual

10     loop (DOLAP) scheme coped well with changes in channel
conditions, the control loops adapting to the changes
without the need for CRC failure.

It will be appreciated that although the invention has

15     been described above in the context of a CDMA system,
the system does not need to be exclusively CDMA. For
example, the invention could be used in a hybrid
CDMA/TDMA system.

- 16 -

Claims

1.    An apparatus for power control in a system for
radio communication between a first station (4) and a
5    second station (R), the apparatus comprising:
power indication means at the first station (4) for
communicating to the second station (R) an indication
of the received power of signals at the first station;
and
10   power control means at the second station (R) for
receiving the indication of received power from the
first station (4) and for accordingly modifying its
transmission power; the power control means comprising
inner control loop (6) means for producing a power
15   control metric; outer control loop means (18) for
producing an outer loop threshold signal (OLT)
dependent on received quality of service (QoS),
wherein the outer control loop means (18) comprises
means for producing a channel error rate signal (ChER)
20   whereby to track channel variations;
characterized in that the outer control loop means (18)
comprises
first outer loop means (36) for monitoring quality
check pass/fail events and in response thereto setting
25   a target channel error rate; and
second outer loop means (40) for receiving the channel
error rate signal and for comparing it with the target
channel error rate signal from the first outer loop
means.
30

2.    An apparatus as claimed in claim 1 wherein the
means for producing a channel error rate (ChER) signal
comprises:
means (20) for producing an information signal
5   containing coded information bits;
means (22) for decoding received information bits from
the information signal,
means (24) for re-encoding the decoded information
bits; and
10   means (26) for comparing the re-encoded version of the
decoded information bits with the information signal to
produce the channel error rate signal.

3.    An apparatus as claimed in claim 1  wherein the
15   quality check pass/fail events are cyclic redundancy
check pass/fail events.

4.    An apparatus as claimed in claim 3 wherein the
first outer loop means (36) comprises means for
20   automatically updating the target channel error rate.

5.    An apparatus as claimed in claim 1 wherein the
first outer loop means (36) is operable to adjust the
outer loop threshold signal.
25

6.    An apparatus as claimed in claim 1 wherein the
system is a code division multiple access (CDMA)
system.

30   7.    A method of controlling power in a system for
radio communication between a first station (4) and a
second station (R), the method comprising:

- 18 -

producing at the first station (4) and communicating to
the second station (R) an indication of the received
power of signals at the first station (4); and
receiving at the second station (R) the indication of
5      received power from the first station (4) and
accordingly modifying the second station's (R)
transmission power;
wherein the step of producing at the first station (4)
comprises producing in an inner control loop (6) a
10     power control metric;
producing in an outer control loop (18) an outer loop
threshold signal (OLT) dependent on received quality of
service (QoS) including producing a channel error rate
signal (ChER) whereby to track channel variations;
15     characterized in that the step of producing in an outer
control loop (18) comprises the step of in a first
outer loop (36) monitoring quality check pass/fail
events and in response thereto setting a target channel
error rate; and in a  second outer loop (40) receiving
20     the channel error rate signal and for comparing it with
the target channel error rate signal from the first
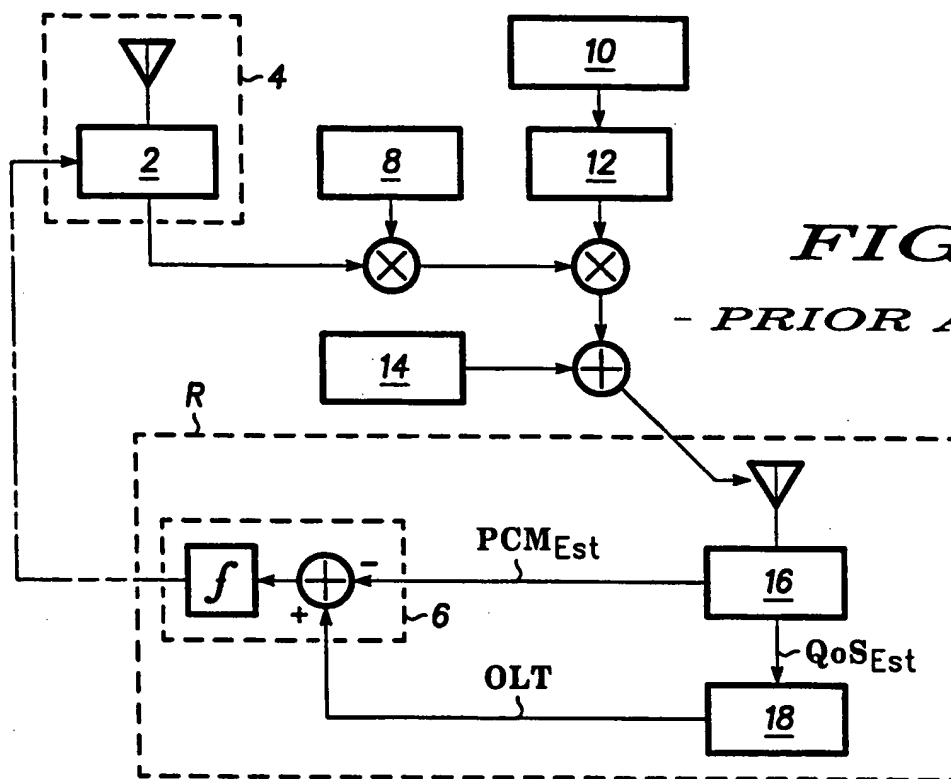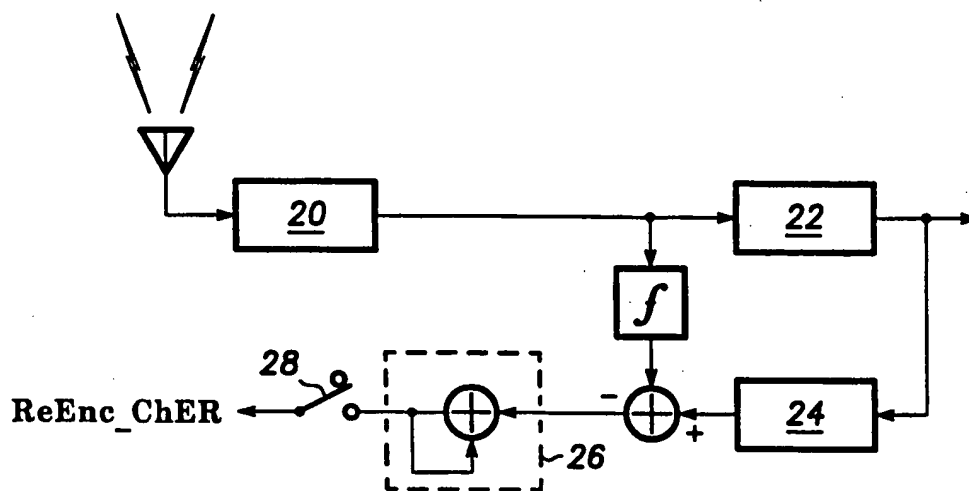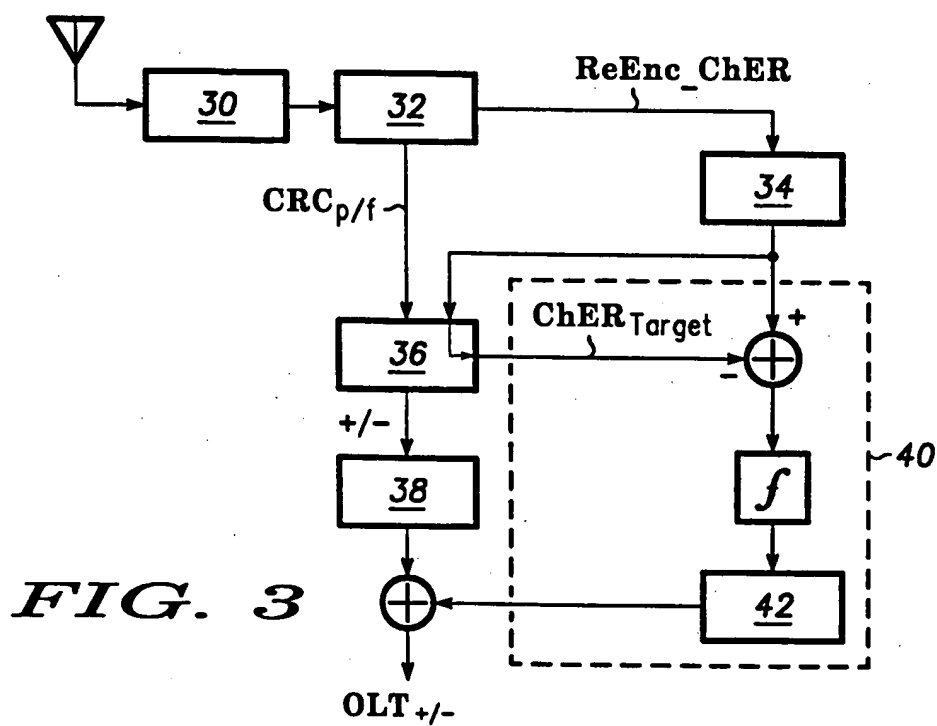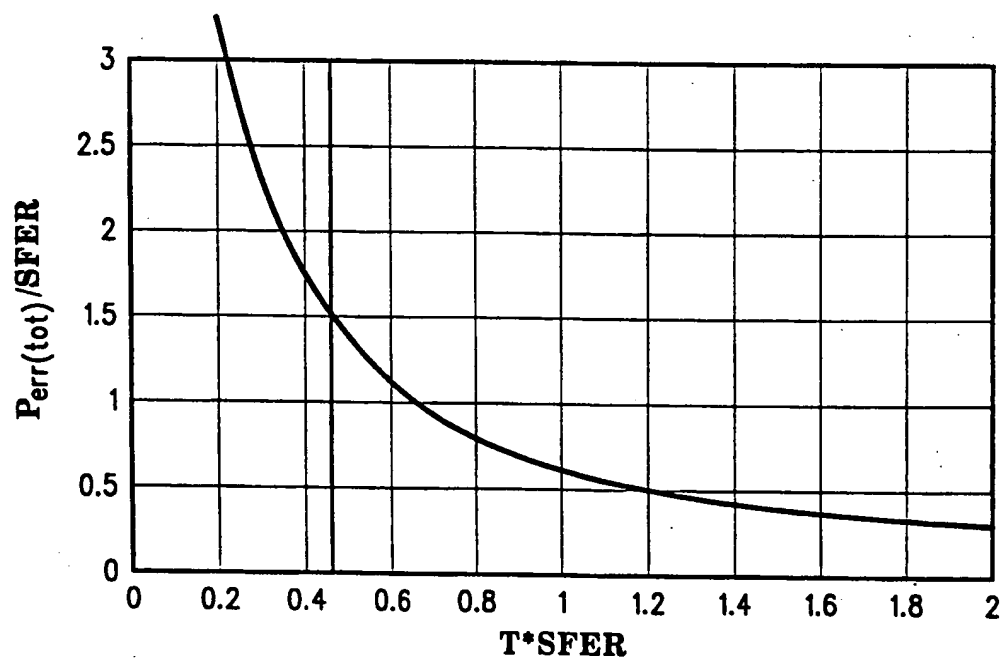outer loop means (36).

FIG. 1
- PRIOR ART -



FIG. 2
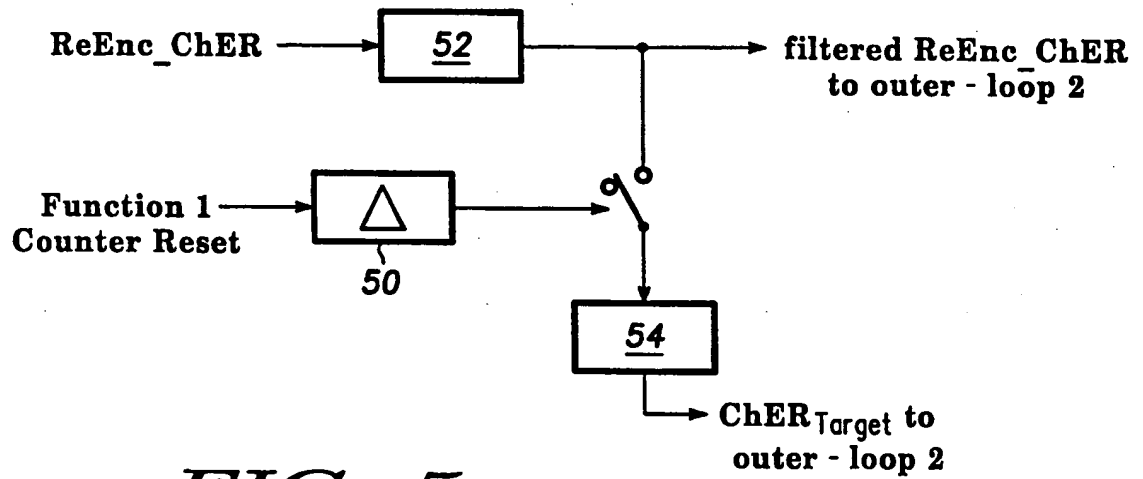
*FIG. 3*



*FIG. 4*

*FIG. 5*

# INTERNATIONAL SEARCH REPORT

**A. CLASSIFICATION OF SUBJECT MATTER**
IPC 7   H04B7/005

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched  (classification system followed by classification symbols)
IPC 7   H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | EP 0 709 973 A (NIPPON TELEGRAPH & TELEPHONE) 1 May 1996 (1996-05-01) column 6, line 4 - line 38 column 8, line 39 - line 50 column 9, line 24 - line 38 column 10, line 1 - line 6 ___ | 1,2,4-7 |
| A | WO 95 08876 A (NOKIA TELECOMMUNICATIONS OY ;MUSZYNSKI PETER (FI)) 30 March 1995 (1995-03-30) page 8, line 4 - line 27 page 10, line 17 -page 11, line 7 page 13, line 6 - line 31 ___ -/-- | 1,3,6,7 |

[X] Further documents are listed in the continuation of box C.      [X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 25 October 2000 | 02/11/2000 |

| Name and mailing address of the ISA<br>European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016 | Authorized officer<br><br>Heinrich, D |
|---|---|

Form PCT/ISA/210 (second sheet) (July 1992)

1

**C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category * | Citation of document, with indication,where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | SAMPATH A ET AL:  "ON SETTING REVERSE LINK TARGET SIR IN A CDMA SYSTEM" PHOENIX, MAY 4 - 7, 1997,NEW YORK, IEEE,US, vol. CONF. 47, 4 May 1997 (1997-05-04), pages 929-933, XP000736744 ISBN: 0-7803-3660-7 | |

1

| Patent document cited in search report | | Publication date | Patent family member(s) | | Publication date |
|---|---|---|---|---|---|
| EP 0709973 | A | 01-05-1996 | CN | 1123976 A,B | 05-06-1996 |
| | | | CN | 1264991 A | 30-08-2000 |
| | | | EP | 1041732 A | 04-10-2000 |
| | | | EP | 1041733 A | 04-10-2000 |
| | | | JP | 3014308 B | 28-02-2000 |
| | | | JP | 8181653 A | 12-07-1996 |
| | | | US | 5873028 A | 16-02-1999 |
| WO 9508876 | A | 30-03-1995 | AU | 683422 B | 13-11-1997 |
| | | | AU | 4821293 A | 10-04-1995 |
| | | | DE | 69307343 D | 20-02-1997 |
| | | | DE | 69307343 T | 24-04-1997 |
| | | | EP | 0671083 A | 13-09-1995 |
| | | | FI | 952518 A | 23-05-1995 |
| | | | JP | 8503829 T | 23-04-1996 |
| | | | US | 5623484 A | 22-04-1997 |